A mobile sensing platform for Smart Cities - CityScan

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FEC7

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STAGE 2 EXPERIMENT

CityScan Concept

CityScan is a cost-efficient multipurpose mobile sensing platform to address the problem of valuable portable items being lost or stolen in the urban environment

Novel lost-found service for personal portable belongings discovery

3-tier Architecture:

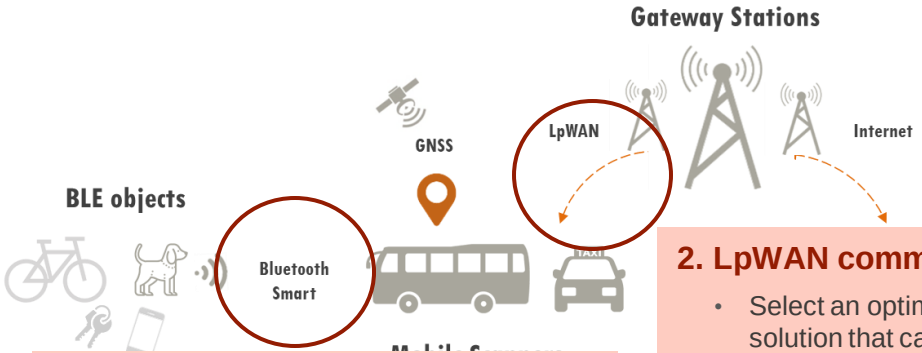
- *Mobile Scanners*
- *Static Gateways*
- *Cloud*

Drive-by approach to cover city with min. number of devices.

Report lost obect to the Cloud

Objectives & Challenges

Development and optimization of the wireless interfaces and communication components for efficient operation in the real-world urban environment



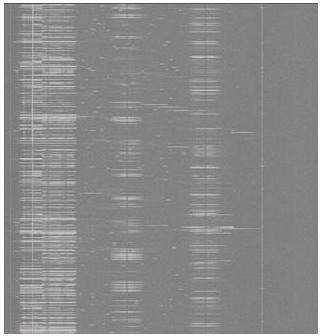
1. BLE Discovery

- To enable fast discovery of stolen objects in a crowded city environment
- To select optimal parameters for scanning duty cycle

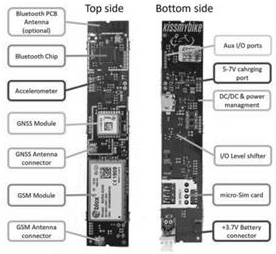
2. LpWAN communication

- Select an optimal communication solution that can deliver required data rate in a real-world urban scenario
- Optimize network range and communication reliability

Experiment Setup: BLE Discovery



Test environment



Mobile Scanners Devices

Test Setup

- Residential street environment
- 6 KMB devices Mobile Scanners
- 6 Test Settings
- Drive-by experiment at 30km/h

Metrics:

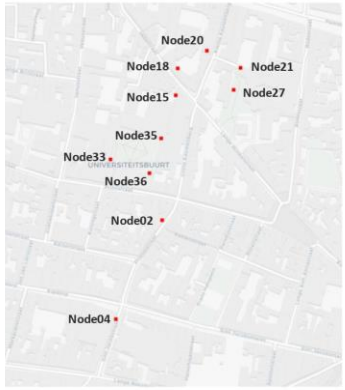
- a distance at which a first discovery of a BLE object was recorded
- a number of successfully received packets with known MAC address in a given time

Test Parameters

	scanWindow (ms)	*scanInterval* (ms)
Setting1	16	16
Setting2	48	64
Setting3	80	80
Setting4	160	160
Setting5	240	240
Setting6	320	320

Experiment Setup: LpWAN

Test environment



Test Setup

- City of Things Antwerp testbed 10 outdoor Nodes
  - *LoS*: Nodes 2, 4, 20 33, 35 and 36
  - *Non-LoS*: Nodes 15, 18, 21 and 27
- Drive-by experiment at 5 and 20km/h
- Sub-1 GHz technologies: LoRa and 2-FSK

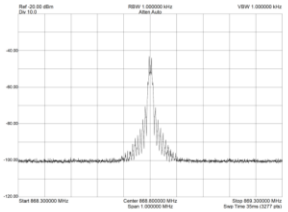
Metrics:

- an effective communication range as a function of PHY setting and velocity

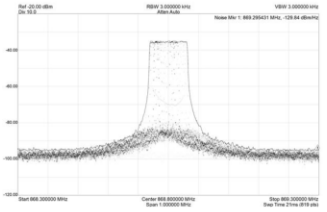
Settings PHY

Parameter	Setting 1	Setting 2	Setting 3	Setting 4
Modulation	LoRa, SF12	LoRa, SF9	Lora, SF7	2-FSK
Bandwidth	125KHz	125KHz	125KHz	20KHz
Output power	14 dBm	14 dBm	14 dBm	14 dBm
Channel	G3 869.5MHz	G3 869.5MHz	G3 869.5MHz	G3 869.5MHz
Preamble	8	8	8	8
Payload	54 Bytes	54 Bytes	54 Bytes	54 Bytes
Code Rate	4/5	4/5	4/5	1
Bit rate	292 bps	1750 bps	5470 bps	9600 bps
Time on air	2438 ms	428 ms	162 ms	56 ms
Symbol time	32 ms	4.6 ms	1.4 ms	0.8 ms
Sensitivity	-137 dBm	-130dBm	-124 dBm	-105 dBm

2-FSK 20KHz

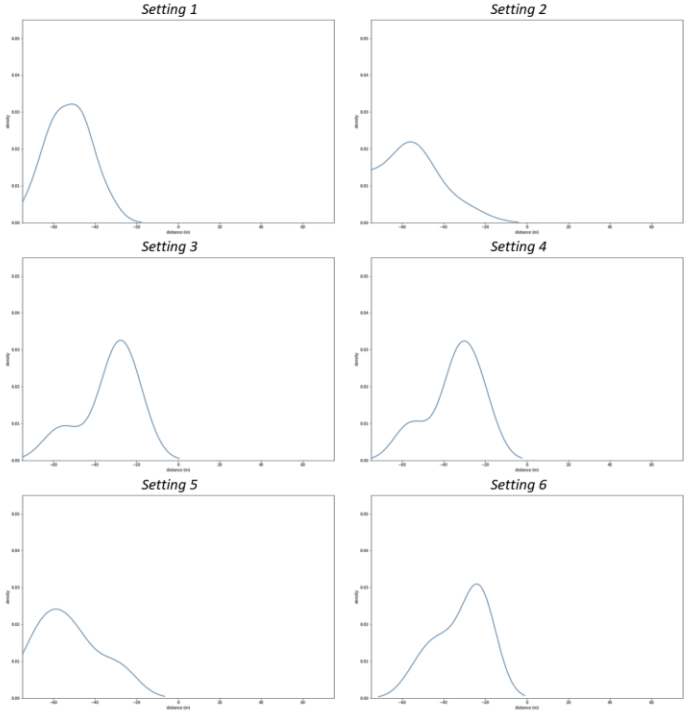


LoRa 125Khz



Experiment Results

BLE discovery



Probability density functions (PDF) of the distance at the first discovery

Number of received advertising PDUs

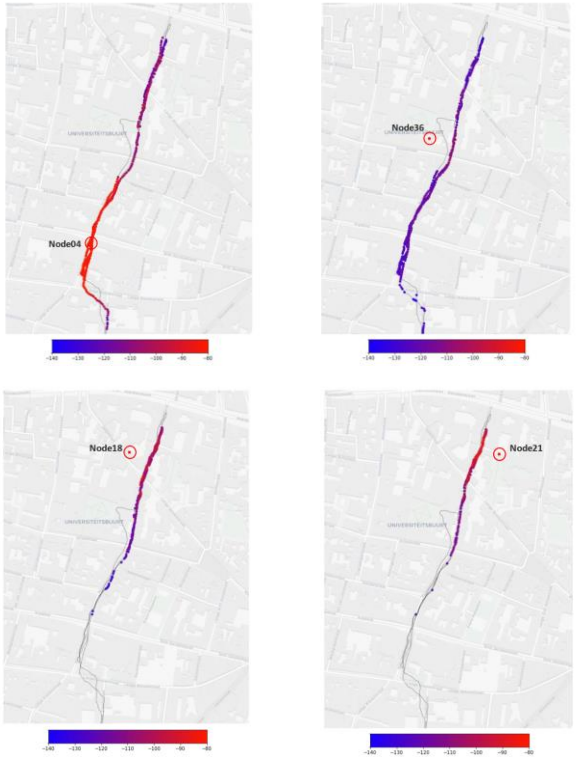
Outcomes:

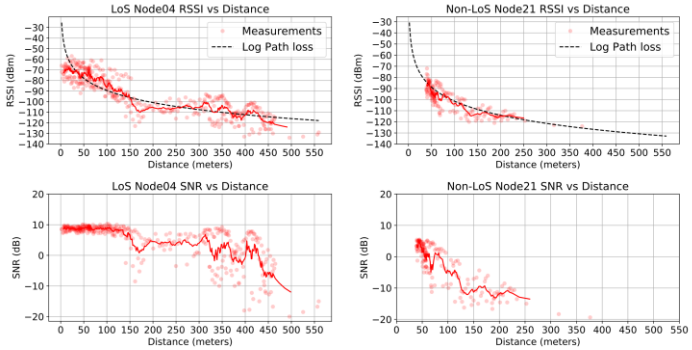
- All settings provided objects detection
- *Setting1* has close to one probability of discovering BLE objects further 20 meters
- *Setting1* provided best performance in PDUs discovery

LpWAN (1/2)

LoS nodes

non-LoS nodes

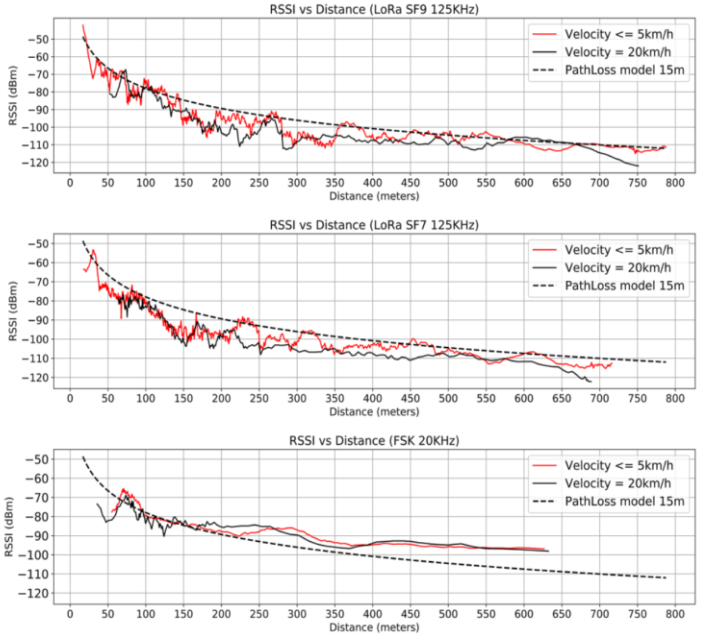




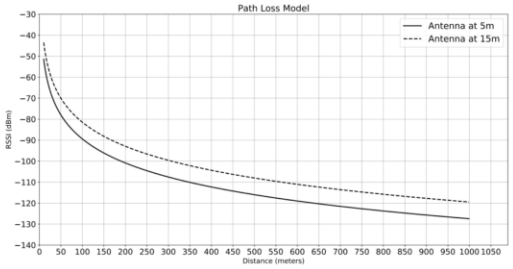
Outcomes:

- City is a challenging environment for LpWAN
- None of the Gateways provided 1000m range
- Difference in LoS and non-Los cases up to 60-70%
- Low-rate settings are not suitable due to EU duty cycle limits

LpWAN (2/2)



High rate settings at 15m gateway installation



Path loss model 5m vs 15m antenna installation

Outcomes:

- 5- vs 15- m antenna installation ~30% improvement
- LoS and clear Fresnel zone are essential
- Delivery control to improve PDR and range
- SF7 and FSK best options to meet EU regulations
- No communication degradation at velocities <= 30km/h

Business Impact

Impact

- Practical knowledge in features and limitations of various LpWAN technologies
- Reinforced our expertise and positioning in delivery new IoT solutions
- Expand our offering to the new markets

Value

HOW DID FED4FIRE HELP US?

- Practical Research outputs for dissemination
- Time and resources reduction to run real-life experiment

Value

WHY DID WE COME TO FED4FIRE?

- Fed4Fire offers versatile environment and set of tools that perfectly matches to our R&D requirements

- Fed4Fire enables us to test various IoT interfaces in realistic environment

Feedback

Used resources and tools

Fed4FIRE Testbed used:

- City of Things Antwerp testbed (imec) – 10 nodes

Fed4FIRE tools used:

- jFed

Other tools were provided by us e.g. 6 KMB GPS devices, 4 mobile LpWAN modules

Added value of Fed4FIRE

The most important added value of Fed4Fire:

- Realistic environment for RF experiments offered by City of Things Antwerp testbed (imec);
- Documentation and support to get started experiments
- Ease of experiments setup
- Diversity of resources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Co-funded by the Swiss Confederation

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WWW.FED4FIRE.EU